Detection of Earth-size planets using K2

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Summary: We propose to use the Kepler telescope to detect transiting planets, particularly Earth-size planets. To this end we provide a catalog of 48,000 stars in K2 Field 0, selected by virtue of planet detectability. Our catalog of relatively small stars (particularly M-dwarfs) with bright Kepler magnitudes are the best targets for transit searching, and provide the best opportunities for follow-up observations.

Target selection: We created a list of the brightest main-sequence stars in Field 0 with special emphasis on small stars. Our starting point was the provisional TESS Dwarf Star Catalog, an all-sky catalog of 3m F5-M5 candidate stars selected from the 2MASS and Tycho-2 and rejecting giants via reduced proper-motion. We added M dwarfs from Lepine & Gaidos (2011), and the MEarth target list (J. Irwin, private communication, 2014). The catalog provides VIJHK magnitudes and an estimated $T_{\rm eff}$ based on those magnitudes. For K2, we chose stars according to apparent-magnitude limit that varies with effective temperature (a proxy for stellar radius), optimized for planet detectability (**see Figure 1**). We selected 87,000 stars (black dots on the Figure) within 12° of the center of the intended K2 Field 0.

Target prioritization: For each star, we evaluated the potential for transiting-planet detection based on its estimated stellar radius and achievable photometric precision (assumed to be 4 times worse than a star of the same apparent magnitude observed by Kepler). We calculated the radius of the smallest transiting planet that could be detected in a 2-day orbit with SNR > 7. Colored lines in **Figure 1** show the minimum planet radius as a function of $m_{\rm Kep}$ and $T_{\rm eff}$. We assigned the stars to three different priority groups. The first group consists of 3,442 stars cooler than 3850 K. The second group consists of 11,436 FGK stars with $m_{\rm Kep} < 11.5$; this group is more problematic because a significant fraction could be subgiants. The third group consists of 32,307 stars of any type for which a 1.75 R_E planet could be detected. Within each group, stars are prioritized according to the smallest detectable planet.

Expected yield: We estimated the yield of K2 based on the transit-detection rates of the normal Kepler mission, assuming that K2 will achieve a photometric precision 4 times worse than Kepler, and assuming that 50% of our catalog's FGK dwarfs are actually subgiants. We predict that approximately 150 planet candidates will be detected, of which 42 are smaller than 2.0 R_E.

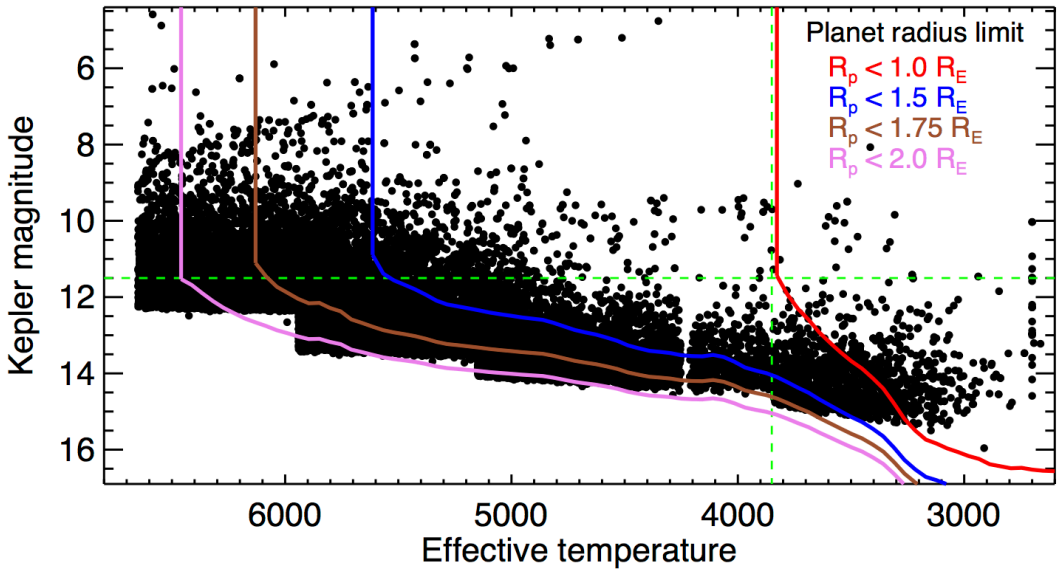

Figure 1. Estimated effective temperatures, and apparent Kepler magnitudes, of the 87,000 stars in our catalog. Colored lines are approximate thresholds for the detection of transiting planets of various sizes.